Ferdinand Braun: A Life of the Nobel Prizewinner and Inventor of the Cathode-Ray Oscilloscope. By Friedrich Kurylo and Charles Susskind. Cambridge, Mass.: MIT Press, 1981. Pp. xv+289; illustrations, notes, index. $29.95.

Ferdinand Braun (1850–1918) was a prominent German physicist who has been forgotten by historians. A contemporary of Heinrich Hertz and Wilhelm Conrad Roentgen, Braun actively pursued research on both the theoretical and applied aspects of electricity. Born into a middle-class family, Braun studied at the University of Marburg and received his doctorate from Hermann von Helmholtz at the University of Berlin in 1872. As a young *Gymnasium* instructor, he was the first to investigate the rectifier effect in semiconductor crystals (in 1874), the phenomenon behind much of solid-state electronics. In 1897, as an established professor at the University of Strasbourg, he invented the cathode-ray oscilloscope, which became the basis for the television tube, computer terminals, and a myriad of other electronic instruments.

Braun's most important work, however, was conducted in the field

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of wireless telegraphy. Puzzled by the limited range of Guglielmo Marconi's transmitter, Braun experimented in 1898 with a resonant antenna circuit that provided an efficient transfer of energy. This powerful and practical design was soon competing successfully with the radio systems of Marconi, Adolf Slaby, and Georg Count Arco. Braun later supplemented his transmitter with the development of a crystal detector, multiple tuning, and a directional antenna. For all of these contributions to radio science, Braun shared the 1909 Nobel Prize in Physics with Marconi. Not only a researcher and academic entrepreneur, Braun was also a personality of diverse interests who wrote satirical verse in his youth and painted watercolors in his later years. In fact, his mischievous literary inclination led him to transmit a poem about drinking as his first official radio message.

This book, the first full-length biography of Braun, is based on manuscript material in the Deutsches Museum and Braun's numerous scientific publications. Written by journalist Friedrich Kurylo, and first published in Germany in 1965, it was subsequently translated by Charles Susskind, who added new information about the history of electronics. Kurylo and Susskind together have created a biography that accomplishes several goals at once. Most prominently, they have thoroughly chronicled Braun's research in electricity, acoustics, thermodynamics, high-frequency physics, and radio science. In recounting specific details of Braun's investigations, they describe how 19th-century experimental physicists pursued their research using simple, low-cost apparatus, doing what might be termed "string and sealing wax" physics (p. 79).

As background for their narration of Braun's research, Kurylo and Susskind reveal much about the academic context of German physics in the last century. Their story is rich in detail, even trivia, about the daily life of a German physics professor, with particular note to the "games of academic musical chairs that start whenever a professor's chair falls vacant" (p. 21). Finally, in addressing Braun's work in wireless telegraphy, the authors effectively place his contributions within the framework of the technical evolution of radio in Europe during the years 1895–1915. More than one-third of the text is devoted to Braun's role in the rise of the German radio industry, especially in the creation of the internationally famous firm Telefunken.

Although their account is lively and multidimensional, the authors could have supplemented this biography with two additional aspects of Braun's career. First, it would have been desirable to know more than simply how Braun got his academic appointments. Braun was obviously a skilled academic entrepreneur, and his institution-building efforts played an important part in the establishment of applied physics as an academic discipline. As one example, how did Braun succeed in getting the Educational Ministry to build him a new physics institute at the University of Tübingen?

Second, while the authors have extended our knowledge of Braun

the scientist, they have paid too little attention to his role as inventor. Braun invented an electric pyrometer, the oscilloscope, and his radio transmitter. Not satisfied with mere laboratory devices, Braun actively promoted their development and commercial exploitation. He negotiated for capital, secured patents, and supervised lengthy commercial tests. Curiously, the authors reveal little about how Braun pursued invention. When he introduced his pyrometer in 1884, was he motivated for economic or intellectual reasons? Why in 1898, as an established academic physicist, did he decide to enter the highly competitive field of wireless telegraphy? When Braun invented his cathode-ray oscilloscope, what was he trying to accomplish? What ideas did he synthesize in creating this new device and how did he use his skills as an experimenter to improve it? In developing his radio transmitter, what strategy of patenting and publication did Braun follow? Did this strategy prevent his company from securing a strong market position? Knowledge of Braun's motivations and methodology as an inventor might have enriched the account of his scientific research. It would have allowed the authors to comment more precisely on the interaction of science and technology in late-19th-century Germany. Moreover, it would have encouraged readers to draw comparisons between the styles of German and American inventors, an approach which could reveal much about the cultural factors shaping the innovation process.

In summary, while Braun does not come across in this biography as either an inventor or institution builder, the reader is given a clear sense of the significance of his inventions and discoveries for the rapid evolution of electronics. Kurylo and Susskind have written a good intellectual biography of a scientist, one rich in information about the history of radio and electronics.

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